An Evolutionary Process of Asset Transformation of Financial Intermediaries

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This paper models the evolutionary process of banks whose roles are information production and asset transformation, the latter being a process of issuing liabilities (deposits) and then investing the proceeds in other risky assets. After we establish the "mixed quality equilibrium" in a capital market where managers and investors have asymmetric information about project quality, we derive cost conditions which motivate the emergence of banks as information producers and asset transformers. If asset transformation is a second-best choice relative to information production, asset transformation could be a mechanism for reducing the incentive cost of banks. A necessary condition for asset transformation to be a first-best choice is that banks are less risk averse than investors.

I. Introduction

The objective of this paper is to model the evolutionary process of financial intermediaries (hereafter, banks) as asset transformers. "Why" do banks exist? This existence question has long been a vital issue to the understanding of the objectives and activities of banks in the capital market.[1] An analysis of the existence of banks provides an economic justification for a specific form of various banking activities. One important banking activity is *asset transformation,* the process of issuing liabilities (deposits) and then investing the proceeds in other assets.

In order to explain the role of banks as asset transformers, researchers have focused upon the ability or motivation of banks to hold diversified portfolios or to produce information about the

[1]For literature survey, see Baltensperger (1980) and Santomero (1984), among others.

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assets held. Klein (1973) and Benston and Smith (1976), among others, suggest that depositors, on their own, hold suboptimal portfolios because of large denomination constraints (Klein) or substantial transaction cost constraints (Benston and Smith), and banks evolve to exploit these constraints.

Leland and Pyle (1977) suggest that the role of banks would be to resolve the problems associated with information asymmetry between borrowers and lenders. Chan (1983), by developing the idea of Leland and Pyle, shows that when the capital market collapses to the "lemons market" due to information asymmetry between managers and investors, banks could evolve as informed agents and contribute to social welfare. Campbell and Kracaw (1980) show that if the capital market cannot scrutinize the assets held by banks (otherwise, information held by banks becomes a public good, and investors can mimic investment decisions of banks), it would be in the best interest of banks with "low quality" assets to produce false information. Diamond (1984), by extending the agency problem model of Campbell and Kracaw, suggests that portfolio diversification is a mechanism for reducing the incentive costs of banks.[2]

The current study improves upon the earlier studies. We may contrast our analysis with the earlier works in at least three different ways. First, we view asset transformation as a simple process of issuing risk-free debt (deposits) and investing the proceeds in a single class of risky assets. Our analysis does not require portfolio diversification in the process of asset transformation. Second, in order to address the moral hazard problem of banks, we explicitly distinguish between the broker bank and the asset transforming bank. The former sells information only, while the latter, utilizing its information, engages in asset transformation. The distinction between the two different banking modes allows us to create a situation in which it is in the best interest of banks to invest in "high quality" assets. Third, our analysis does not set up a "lemons market" in order to motivate the emergence of banks. In our model, the capital market under Chan-type information asymmetry establishes a mixture of the conventional competitive equilibrium and the Akerlof-type (1970) lemons market equilibrium, which we shall call the *mixed quality equilibrium*. The analysis of the evolutionary process

[2]Ramakrishnan and Thakor (1984) suggest that the coalition of banks reduces their incentive costs. Boyd and Prescott (1983) argue that the dishonesty issue might have been overemphasized because criminal charges make the cost of dishonesty extremely risky.

of banks becomes relatively simple after the mixed quality equilibrium is established.

In brief, by examining the cost conditions which justify the emergence of the broker bank and the asset transforming bank, our main results reinforce and integrate those of the earlier studies. First, if asset transformation is a second-best choice relative to brokerage, asset transformation is likely to be a mechanism for reducing the incentive cost of the bank. Second, for asset transformation to be a first-best choice of the bank, the bank must be less risk averse than investors. Finally, if the social benefit of asset transformation exceeds the extra cost incurred in the process of asset transformation, and if the marginal benefit of asset transformation exceeds the marginal extra cost, asset transformation becomes a more efficient form of banking than brokerage in terms of social welfare.

We organize the remainder of the paper as follows: Section II presents a two-period rational expectations equilibrium for the capital market without banks and shows how the capital market establishes the mixed quality equilibrium. Section III discusses the role of banks as information producers and asset transformers. The last section is a summary of the paper.

II. Capital Market without Banks

A. Assumptions

There are two periods: $t = 0$ denotes the beginning of the first period, and $t = 1$ the end of the first period. There are potentially many risk averse investors and a fixed number, N, of risk neutral managers.[3] At $t = 0$, each manager develops one unit of an investment project that lasts two periods.[4] There are two types of projects, differentiated by managers' initial development (sunk) costs, C_H and C_L, where $C_H > C_L$. Information asymmetry between managers and investors means that investors cannot observe managers' development costs. We will show later that H-type projects have higher quality than L-type projects.

[3]Though risk aversion of managers is an important factor in determining optimal contracts in the principal-agent relation (see, for example, Shavell 1979), our primary concern is to show how the lemons market can be avoided in the presence of information asymmetry. The existence of the mixed quality equilibrium is invariant with respect to risk aversion or neutrality of managers and/or investors.

[4]We exclude the uninteresting possibility of managers self-owning projects.

TABLE 1
INFORMATION STRUCTURE

initial cost	conditional probabilities of R_H	R_L
C_H	p	$1-p$
C_L	$1-p$	p

Note: $\frac{1}{2} \leq p < 1$

At the end of each period, the investment projects yield a random return, $\tilde{R}$, which takes on one of two values, R_H or R_L, where $R_H > R_L$. The realized returns are public information, so there is no *ex post* information asymmetry between managers and investors[5] about the realized return. Table 1 shows probabilities of R_H and R_L conditional upon initial development costs. p is not less than 1/2, so $R_H(R_L)$ is more closely related to $C_H(C_L)$.[6] The probability distribution itself is common knowledge.

At $t = 1$, when they observe the realized return, investors infer project quality to some degree by using the information structure in Table 1. By Blackwell's sufficiency theorem,[7] the random return, $\tilde{R}$, becomes more informative as p increases. If $p = 1/2$, $\tilde{R}$ does not carry any useful information. If $p = 1$, $\tilde{R}$ is perfectly informative. If $1/2 < p < 1$, $\tilde{R}$ is partially informative.

Given the probabilistic relations between project development costs and realized returns in Table 1, the conditional means and variances of $\tilde{R}$ are

$$E(\tilde{R} \mid C_H) = pR_H + (1-p)R_L \tag{1}$$

$$E(\tilde{R} \mid C_L) = (1-p)R_H + pR_L \tag{2}$$

$$\sigma^2(\tilde{R} \mid C_H) = \sigma^2(\tilde{R} \mid C_L) = p(1-p)(R_H - R_L)^2. \tag{3}$$

It follows that $E(\tilde{R} \mid C_H) > E(\tilde{R} \mid C_L)$ if and only if $p > 1/2$. If the average return of H-type projects is greater than that of L-type projects, the random return, $\tilde{R}$, becomes informative. Since $\sigma^2(\tilde{R} \mid C_H) = \sigma^2(\tilde{R} \mid C_L)$, we hereafter call H-type projects the high quality project and L-type projects the low quality project.

[5]This assumption is required to avoid the moral hazard problem of managers who may attempt to fool investors by a false report.

[6]We may have different probabilities for $\Pr\{\tilde{R} = R_H \mid C_H\}$ and $\Pr\{\tilde{R} = R_L \mid C_L\}$. This does not alter our analysis.

[7]See DeGroot (1970) for the sufficiency theorem.

At $t = 0$, when investors enter the capital market, they have a homogeneous belief, θ, about the chance that they will purchase the high quality project. In a self-fulfilling rational expectations equilibrium, θ must be equal to the proportion of high quality projects. Since we will introduce banks to the mixed quality equilibrium, we assume that $0 < \theta < 1$.[8]

At $t = 0$, given θ and p, investors have a prior probability that the project yields R_H at $t = 1$, $\phi\ (\equiv \Pr\{\tilde{R} = R_H \text{ at } t = 1 \mid \theta, p\})$:

$$\phi(\theta) = p\theta + (1 - p)(1 - \theta). \tag{4}$$

Since $0 < \theta < 1$, it follows that $0 < \phi(\theta) < 1$.

At $t = 1$, when they observe the realized return, investors assess posterior probabilities about project quality. Let $\zeta_H(\theta)$ be the probability that the project is a high quality project given that its realized return at $t = 1$ is R_H, and let $\zeta_L(\theta)$ be the probability that the project is a low quality project given that its realized return at $t = 1$ is R_L. Using Bayes' rule, we have

$$\zeta_H(\theta) = \frac{p\theta}{\phi(\theta)}, \tag{5}$$

$$\zeta_L(\theta) = \frac{p(1 - \theta)}{1 - \phi(\theta)}. \tag{6}$$

Both ζ_H and ζ_L increase, given θ, when p increases.

In order to focus the analysis on quality choice, we assume that each investor purchases one unit of the project. A manager and a matched investor determine (market equilibrium) wages for managerial services in the following way. At $t = 0$, when they are unable to distinguish between high and low quality projects, investors pay W_0 for the first period's managerial service. At $t = 1$, when they observe the realized return of R_H or R_L, investors pay W_H or W_L, respectively. Note that these wages are endogenous variables.

We further assume that investors bear the cost of locating a manager with an available project. This information search cost, I, is an increasing function of the market size, i.e., the number of managers, N.[9] Equation (7) describes investors' one-period expected

[8]See Dokko and Kim (1987) for the case where $\theta = 0$ and $\theta = 1$, and for the details of the mixed quality equilibrium.

[9]Because each manager offers one unit of the project, if more than one investor visits a manager, the investors except one should search for other managers. Given potentially many investors, as the number of managers increases, so does the average number of costly searches an investor has to make before being able to purchase one project.

utility (or the certainty equivalent return) from the project:[10]

$$U(\mathrm{E}(\tilde{R}),\ \sigma^2,\ X) = \beta\,(\mathrm{E}(\tilde{R}) - r\sigma^2) - X \qquad (7)$$

where $\beta\,(0 < \beta < 1)$ is the discount factor, $\mathrm{E}(\tilde{R})$ is the expected return, σ^2 is the variance of $\tilde{R}$, $r(r \geq 0)$ is the measure of investors' risk aversion, and X represents immediate cash outflows. At $t = 0$, $X = W_0 + I(N)$. At $t = 1$, $X = W_H$ or W_L.[11]

At $t = 1$, given that the realized return is R_H or R_L, investors' conditional expected utility for the second period is U_H or U_L, respectively:

$$U_H = \beta\,\{\zeta_H\,\mathrm{E}(\tilde{R} \mid C_H) + (1 - \zeta_H)(\tilde{R} \mid C_L) - r\sigma^2\} - W_H, \qquad (8)$$

$$U_L = \beta\,\{(1 - \zeta_L)\mathrm{E}(\tilde{R} \mid C_H) + \zeta_L\mathrm{E}(\tilde{R} \mid C_L) - r\sigma^2\} - W_L. \qquad (9)$$

At $t = 0$, investors' two-period expected utility, U_0, is

$$\begin{aligned} U_0 = \beta\ &\{\theta\,\mathrm{E}(\tilde{R} \mid C_H) + (1 - \theta)\,\mathrm{E}(\tilde{R} \mid C_L) - r\sigma^2\} \\ &- W_0 - I(N) + \beta\{\phi\,U_H + (1 - \phi)U_L\}. \end{aligned} \qquad (10)$$

Because of competition among potentially many investors, they are willing to invest as long as they earn reservation expected utility, which is assumed to be zero without loss of generality.

Finally, given equilibrium wages and the information structure in Table 1, managers' net present values (NPV) of the high and low quality projects, NPV_H and NPV_L, are

$$NPV_H = -C_H + W_0 + \beta\,\{pW_H + (1 - p)W_L\}, \qquad (11)$$

$$NPV_L = -C_L + W_0 + \beta\,\{(1 - p)\,W_H + pW_L\}\,. \qquad (12)$$

B. The Mixed Quality Equilibrium

In equilibrium, managers must be indifferent as to whether they develop the high or low quality project; that is, $NPV_H = NPV_L$. Using equations (11) and (12), we have

$$\Delta W = \frac{\Delta C/\beta}{2p - 1} \quad \text{for } p > 1/2 \qquad (13)$$

[10]This type of utility function is very convenient when one is primarily concerned with quality choice; see, for example, Wiggins and Lane (1983).

[11]Equilibrium wages mean that no investors will search for another manager at $t = 1$. Hence, the information search cost incurs only at $t = 0$.

where $\Delta W(\equiv W_H - W_L)$ is the wage differential at $t = 1$, and ΔC $(\equiv C_H - C_L)$ is the project development cost differential (its future value at $t = 1$ is $\Delta C/\beta$). Equation (13) shows the manager's required wage differential between the high and low quality projects. As the random return becomes less informative (i.e., p decreases), managers require a higher wage differential for undertaking the high quality project.[12]

For investors, equilibrium wages mean that their conditional expected utilities at $t = 1$, U_H and U_L, are the same. Using equations (8) and (9), we have

$$\Delta W = \beta\{\zeta_H(\theta) + \zeta_L(\theta) - 1\}\Delta \mathrm{E}(\tilde{R}) \tag{14}$$

where $\Delta \mathrm{E}(\tilde{R}) = E(\tilde{R} \mid C_H) - \mathrm{E}(\tilde{R} \mid C_L)$. Equation (14) shows the wage premium adjusted for the imperfect information structure, that investors are willing to pay for being indifferent between the high and low quality projects. For example, if $p = 1$, $\Delta W = \beta \Delta \mathrm{E}(\tilde{R})$; and if $p = 1/2$, $\Delta W = 0$.

Combining equations (13) and (14) determines the mixed quality equilibrium, equation (15):

$$\frac{\Delta C/\beta}{2p - 1} = \beta[\zeta_H(\theta) + \zeta_L(\theta) - 1]\Delta \mathrm{E}(\tilde{R}). \tag{15}$$

We can now solve equation (15) for the equilibrium proportion of high quality projects (if it exists). Figure 1 shows solutions of equation (15) when $1/2 < p < 1$. For the solutions of equation (15) to exist, the maximum of the right hand side of equation (15), $\beta(2p - 1)^2(R_H - R_L)$, must not be less than the left hand side. This existence condition requires the information structure to satisfy the following condition:

$$p \geq [(1/2) + (1/2)(\Delta C/\beta^2)/\Delta R^{1/3}] \equiv p_{\min}(> 1/2)$$

where $\Delta R \equiv R_H - R_L$. In order to avoid the lemons market, the information content in the random return must exceed a certain minimum level, $p_{\min}$. Assuming that $p \geq p_{\min}$, there are two possible solutions, θ' and θ^*, in Figure 1. We take θ^* as the equilibrium solution in that only θ^* is stable. If θ is less (greater) than θ', the premium that investors are willing to pay is greater (less) than the manager's required wage differential. The manager's incentive to

[12]If $p = 1/2$, the required wage differential becomes infinite. In other words, the Akerlof lemons principle holds.

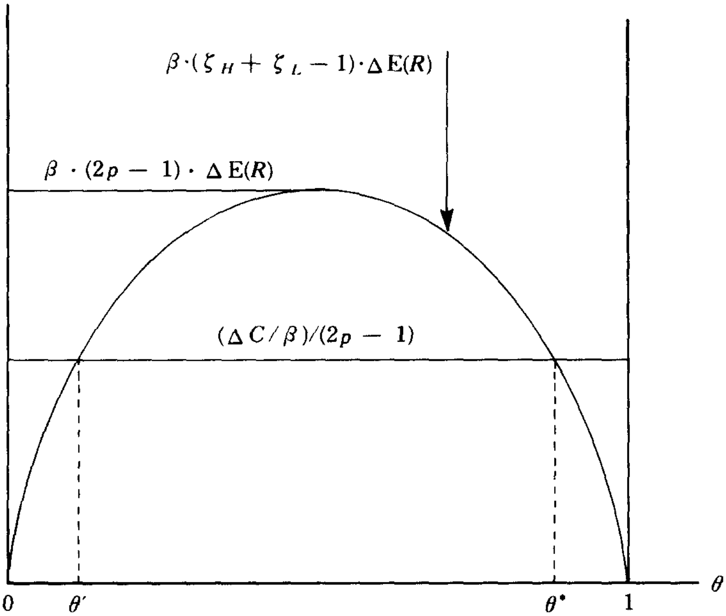

FIGURE 1
THE MIXED QUALITY EQUILIBRIUM IN THE CAPITAL MARKET UNDER INFORMATION ASYMMETRY

undertake the high (low) quality project increases; thus, the proportion of high (low) quality projects increases.

Finally, for our later analysis, we determine equilibrium wages from the zero reservation utility conditions. $U_0 = U_H = U_L$ leads to

$$W_0 = \beta[\theta^* E(\tilde{R} \mid C_H) + (1-\theta^*)E(\tilde{R} \mid C_L) - r\sigma^2] - I(N), \tag{16}$$

$$W_H = \beta[\zeta_H(\theta^*)E(\tilde{R} \mid C_H) + (1-\zeta_H(\theta^*))E(\tilde{R} \mid C_L) - r\sigma^2], \tag{17}$$

$$W_L = \beta[(1-\zeta_L(\theta^*))E(\tilde{R} \mid C_H) + \zeta_L(\theta^*)E(\tilde{R} \mid C_L) - r\sigma^2]. \tag{18}$$

We assume that these equilibrium wages yield a non-negative NPV to managers.

III. Modelling Banks

Given that the capital market is in the mixed quality equilibrium, we now introduce banks at $t = 0$ as perfectly informed agents. We define perfect information as knowledge of both location and quality of available projects. Perfectly informed agents can purchase the project before uninformed investors. Therefore, the size of the capital market where investors are uninformed shrinks by the number of perfectly informed agents. Since the capital market size does not affect the mixed quality equilibrium (i.e., $\partial\theta^*/\partial N = 0$),[13] the presence of perfectly informed agents does not affect θ^* either.

A. Value of Perfect Information

Before we discuss the condition for the evolution of banks, it is useful to consider a situation where each investor can have perfect information at some fixed cost, F, while no banks yet exist. Let n be the number of perfectly informed investors. The $N-n$ remaining managers will sell their projects to uninformed investors. Perfectly informed investors behave in the Nash way; they assume that others do not change their investment strategies. Also, perfectly informed investors do not have to confess the possession of perfect information to managers.

With perfect information at $t = 0$, investors' two-period expected utility from the high quality project, $U_{0|H}$, is (we will show later that perfectly informed investors do not invest in the low quality project):

$$\begin{aligned} U_{0|H} &= \beta(1+\beta)\{E(\tilde{R} \mid C_H) - r\sigma^2\} - W_0 \\ &\quad - \beta\{pW_H + (1-p)W_L\}. \end{aligned} \tag{19}$$

By substituting equilibrium wages from equations (16)~(18) into the wages of U_0 and $U_{0|H}$ (note that $I(N)$ in equation (16), the information search cost, is now $I(N-n)$), and then, by subtracting U_0 from $U_{0|H}$, we compute the expected gain from perfect information, $G(n)$, as a decreasing function of n:[14]

$$G(n) = (1-\theta^*)\{\beta(1+\beta)\Delta E(\tilde{R}) - \Delta C\} + I(N-n) > 0 \tag{20}$$

where $\Delta E(\tilde{R}) \equiv E(\tilde{R} \mid C_H) - E(\tilde{R} \mid C_L)$, and $\Delta C \equiv C_H - C_L$. The utility differential between the high and low quality projects is $\{\beta(1+\beta)\Delta E(\tilde{R}) - \Delta C\}$, and the uninformed investor's probability of obtaining the low quality project is $(1-\theta^*)$. The product of these two terms plus information search cost saving, $I(N-n)$,

[13] N does not appear in the mixed quality equilibrium condition, equation (15).

[14] From equation (15), $\beta(2p-1)\Delta E(\tilde{R}) \geq (\Delta C/\beta)/(2p-1)$ because $(\zeta_H + \zeta_L - 1) \leq (2p-1)$. Hence, $\beta^2\Delta E(\tilde{R}) > \beta^2(2p-1)^2\Delta E(\tilde{R}) \geq \Delta C$ for $p < 1$. It follows that G is always positive.

becomes the expected gain from perfect information.

The equilibrium number of perfectly informed investors, n^*, is determined where $G(n)$ is equal to F (see Figure 2). Since $dG/dn < 0$, the assumption that $G(0) > F$ and $G(N) < F$ ensures that $0 < n^* < N$. We can show that $dG/dp < 0$;[15] the gain from perfect information decreases as the random return becomes more informative. It follows that $dn^* / dp < 0$.

The availability of perfect information reduces the information search cost of uninformed investors from $I(N)$ to $I(N - n^*)$, thereby increasing W_0 (see equation (16)) and managers' NPV. In our model, the sum of managers' NPVs and consumer surpluses measures social welfare.[16] Since investors' expected utility remains the same regardless of whether they are uninformed or perfectly informed, the availability of perfect information increases social welfare.

Finally, perfectly informed investors have no incentives to invest in the low quality project. If they invest in the low quality project, the gain from perfect information becomes

$$G(n) - \{\beta(1 + \beta)\Delta \mathrm{E}(R) - \Delta C\}$$

which is less than $G(n)$ for all n.

B. The Monopolistic Bank: Brokerage

Are banks still likely to evolve even when investors can be perfectly informed at some cost? We first consider a monopolistic broker bank that sells perfect information to the investors. We assume that the broker bank is honest for our banchmark analysis.

When the broker bank serves $n_B(< N)$ pairs of investors and managers, the remaining $N - n_B$ managers sell the projects to uninformed investors. The bank will charge, G, as computed in equation (20), for its information service because at such fee investors will be indifferent between informed and uninformed investment strategies. Therefore, $G(n)$ is the demand price for the information service of the bank. This information service fee must not exceed the information acquisition cost, F.

We assume that the broker bank also spends F to be perfectly informed (e.g., an irrevocable entry fee into the business of financial

[15] $dG/dp = -(d\theta/dp)\{\beta(1 + \beta)\Delta \mathrm{E}(\tilde{R}) - \Delta C\} + 2(1 - \theta)(1 + \beta)\Delta R$. A tedious calculation yields $(d\theta/dp)(2p - 1) > 4(1 - \theta)$, which implies $dG/dp < 0$.

[16] When we introduce banks, social welfare includes risk adjusted profits of banks.

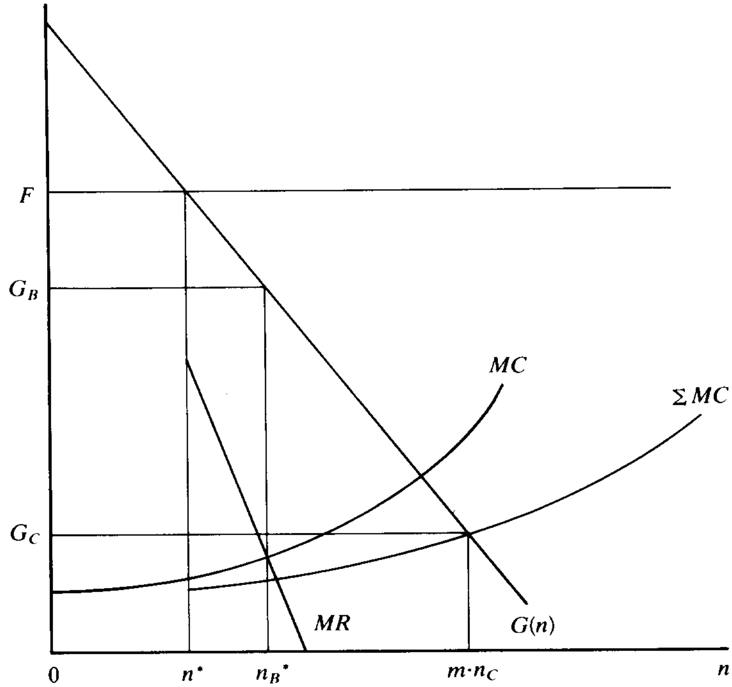

FIGURE 2
MONOPOLISTIC AND COMPETITIVE EQUILIBRIUM OF THE BROKER BANK

brokerage) and bears variable costs, V_B (a strictly increasing and convex function of n_B), of handling its customers. The broker bank's profit, π_B, is

$$\pi_B(n_B) = n_B\, G(n_B) - V_B(n_B)F. \tag{21}$$

Adjustment for risk is not required since the broker bank does not assume any risk.

In Figure 2, we draw the demand (G), marginal revenue (MR) and marginal cost (MC) curves of the broker bank. Note that the marginal revenue curve is discontinuous at n^*, which is the equilibrium number of perfectly informed investors when no banks exist. Unless the broker bank has such a high cost condition that the marginal cost curve intersects the horizontal or discontinuous part of the marginal revenue curve, the optimal number of the broker bank's customers, n_B^*, is greater than n^* at the fee of G_B, which is less than F.

More specifically, we express the condition for the emergence of the broker bank ($n_B{}^* > n^*$) in terms of exogenous cost functions. By the definition of n^*,

$$\frac{d\pi_B}{dn_B} \gtrless 0 \quad \text{for } n_B \lessgtr n_B{}^*.$$

Therefore, $n_B{}^* > n^*$ if and only if

$$\left.\frac{d\pi_B}{dn_B}\right|_{n^B=n^*} > 0.$$

Note that $G(n^*) = F$ and, from equation (20), $dG(n^*)/dn = -dI(N - n^*)/dn$. By evaluating $d\pi_B/dn_B$ at n^*, it follows that $n_B{}^* > n^*$ if and only if

$$F - n^* \frac{dI(N-n^*)}{dn} > \frac{dV_B(n^*)}{dn}. \tag{22}$$

If the marginal benefit to the investors when the broker bank provides perfect information (the left hand side of inequality (22)) exceeds the marginal cost of the brokerage service (the right hand side), then the broker bank evolves. An $n_B{}^*$ exceeds n^*, the information search cost of uninformed investors further decreases, thereby increasing managers' *NPV* and social welfare.

Some comparative static results on $n_B{}^*$ (assuming the cost condition (15) is met) provide welfare implications of the broker bank:

1. $dn_B{}^*/dp < 0$. As the random return becomes more informative, the bank's contribution to social welfare decreases.

2. $dn_B{}^*/dN > 0$. As the potential size of the capital market increases, the bank's contribution to social welfare increases.

3. $dn_B{}^*/di > 0$ (assuming that $I(N - n) = i \times (N - n)$). As the information search cost increases, the number of the broker bank's customers increases. This result would parallel the suggestion of Benston and Smith (1976) that the role of banks is to minimize the transaction cost.

C. *The Monopolistic Bank: Asset Transformation.*

We now consider a monopolistic bank that issues risk-free bonds (deposits)[17] and invests the proceeds in high quality projects. Since

[17] We assume that the ability of the bank to issue risk-free bonds is exogenously given by FDIC deposit insurance.

perfectly informed agents have no incentive to invest in the low quality project, we do not need to consider dishonesty of the bank when it engages in asset transformation. Investors now buy either the risk-free bond from the bank or the risky investment project from a manager. Since U_0 is equal to zero in equilibrium, we assume that the net present value of the risk-free bond is zero. For clear exposition, we assume that the bank issues one share of the risk-free bond against one unit of the high quality investment project; the bank matches the number of bonds (i.e., customers) with that of risky assets.

The risk adjusted profit of the asset transforming banks, π_T, is

$$\begin{aligned}\pi_T(n_T) &= n_T[\beta(1+\beta)\{E(\tilde{R} \mid C_H) - r_T\sigma^2\} - W_0 \\ &\quad - \beta\{pW_H + (1-p)W_L\}] - V_T(n_T) - F\end{aligned} \tag{23}$$

where n_T is the number of customers of the asset transforming bank, r_T, is its risk aversion measure, and V_T is its variable cost.

Define $\epsilon(n)$ such that $V_T(n) \equiv V_B(n) + \epsilon(n)$; ϵ is additional variable cost incurred in the process of asset transformation (e.g., the FDIC insurance premium). We assume that $\epsilon(0) = 0$, and that ϵ is strictly increasing and convex function of n. When market equilibrium wages from equations (16)~(18)(note that $I(N)$ now becomes $I(N - n_T)$) are substituted into W_0, W_H and W_L in equation (16), π_T becomes:

$$\begin{aligned}\pi_T &= n_T\{G(n_T) + \beta(1+\beta)(r - r_T)\sigma^2\} - V_T(n_T) - F \\ &= \pi_B(n_T) + n_T\{\beta(1+\beta)(r - r_T)\sigma^2\} - \epsilon(n_T).\end{aligned} \tag{24}$$

Define S as $\beta(1+\beta)(r - r_T)\sigma^2$; S is the social gain per unit of the risky asset in the presence of the asset transforming bank relative to that of the broker bank. Hence, $n_T S - \epsilon(n_T)$ measures the *net* social benefit of asset transformation over brokerage. From this social benefit, we derive cost conditions which motivate the broker bank to engage in asset transformation. Let n_T^* be the optimal number of customers of the asset transforming bank.

First, if $n_T^* S - \epsilon(n_T^*) < 0$, it follows that $\pi_T(n_T^*) < \pi_B(n_T^*) < \pi_B(n_B^*)$; the second inequality holds by the definition of n_B^*. In this situation, asset transformation is a second-best choice relative to brokerage. Suppose the broker bank has to pay substantial incentive costs to convince the investors that $\pi_B(n_B^*)$ minus the incentive cost is less than $\pi_T(n_T^*)$. Then, asset transformation might be justified as a mechanism for reducing the incentive cost of the broker bank.

Second, if $n_T{}^*S - \epsilon(n_T{}^*) > 0$, it follows that $\pi_T(n_T{}^*) > \pi_B(n_T{}^*)$. In this situation, the bank would have a motivation to engage in asset transformation (though not a sufficient condition yet). For the net social benefit from asset transformation to be positive, r (investors' risk aversion measure) must not be smaller than r_T (asset transforming bank's risk aversion measure). Hence, a necessary condition for asset transformation to occur is that the bank is less risk averse than investors.

Third, if $n_B{}^*S - \epsilon(n_B{}^*) > 0$, it follows that $\pi_T(n_B{}^*) > \pi_B(n_B{}^*)$. By the definition of $n_T{}^*, \pi_T(n_T{}^*) > \pi_T(n_B{}^*)$. Asset transformation becomes a first-best choice of the bank.

Fourth, if $n_B{}^*S - \epsilon(n_B{}^*) > 0$, and if $S > d\epsilon(n_T{}^*)/dn$, it follows that $n_T{}^* > n_B{}^*$. In this situation, since managers' NPV further increases, social welfare in the presence of the asset transforming bank is definitely larger than social welfare in the presence of the broker bank; in terms of social welfare, asset transformation becomes a more efficient form of banking than brokerage. For $n_T{}^*$ to be greater than $n_B{}^*$, it must be that $d\pi_B(n_T{}^*)/dn < 0$. By the definition of $n_T{}^*$,

$$\frac{d\pi_T(n_T{}^*)}{dn} = \frac{d\pi_B(n_T{}^*)}{dn} + S - \frac{d\epsilon(n_T{}^*)}{dn} \equiv 0.$$

Therefore, $d\pi_B(n^*)/dn < 0$ if and only if $S - d\epsilon(n_T{}^*)/dn > 0$.

Finally, additional comparative static results on $n_T{}^*$ would be: i) $dn_T{}^*/d(r - r_T) > 0$, and ii) $dn_T{}^*/d\sigma^2 > 0$. As investors become more risk averse or as the investment project becomes riskier, social welfare contribution of the asset transforming bank increase.

D. Competitive Banks: Brokerage[18]

Suppose there are m identical, competitive broker banks, each handling n_C customers. The total number of investors served by competitive banks is $m \times n_C$. We assume that the variable cost of a competitive broker bank is the same as that of the monopolistic broker bank, that each competitive bank must spend F to be perfectly informed, and that competitive banks earn zero profit.

[18]We consider only the case of competitive broker banks. The case of asset transformation can be similarly analyzed.

Figure 2 also contains the competitive market equilibrium. In Figure 2, $\sum MC$ is the horizontal sum of individual marginal cost curves. The intersection of the G and $\sum MC$ curves determines the information service fee (G_C) and the total number of investors served by competitive banks. With the presence of competitive broker banks, more investors become informed at a lower information service fee (i.e., $m \times n_C^* > n_B^*$ and $G_C < G_B$), thereby increasing managers' NPV. Social welfare with competitive banks is obviously larger than that without banks. However, a welfare comparison between competitive banks and the monopolistic bank is not clear because total spending on information acquisition by competitive banks ($m \times F$) may be too excessive.

IV. Summary

This paper has presented an evolutionary process of banks as information producers and asset transformers. When the bank is an information producer, it may have a cost advantage in acquiring information relative to investors. If investors do not trust the bank, asset transformation could be a mechanism for reducing incentive costs. For asset transformation to be a first-best choice, a necessary condition is that the bank is less risk averse than investors.

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